

We claim:

1. An apparatus for amplifying two collinearly propagating beams of monochromatic coherent radiation at optical frequencies  $\nu_o$  and  $\nu'_o$  comprising:

5 a vessel for containing a gas volume and maintaining an excitation in the gas volume wherein

intense narrow-band fluorescence is emitted from said excitation at frequencies  $\nu_o$  and  $\nu'_o$  of allowed optical transitions of constituents of the gas, wherein said optical transitions share a common upper energy level and form a  $\Lambda$ -type  
10 structure, and wherein one or both lower energy levels are populated in said gas volume, whereby monochromatic laser beams at frequencies  $\nu_o$  and  $\nu'_o$  propagating collinearly through said gas volume containing vessel nonlinearly convert photons from said fluorescence into photons of said propagating beams, thus amplifying said beams.

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2. The apparatus of claim 1, further comprising:

means for producing monochromatic laser beams at  $\nu_o$  and  $\nu'_o$ .

3. The apparatus of claim 2, wherein the monochromatic laser beams at frequencies  $\nu_o$

20 and  $\nu'_o$  are continuous (CW) laser beams.

4. The apparatus of claim 2, wherein the monochromatic laser beams at frequencies  $\nu_o$

and  $\nu'_o$  are pulsed laser beams.

5        5. The apparatus of claim 2, wherein the monochromatic laser beams at frequencies  $\nu_o$   
and  $\nu'_o$  are laser beams each comprising a continuous series of Q-switched  
pulses.

10       6. The apparatus of claim 2, wherein the monochromatic laser beams at frequencies  $\nu_o$   
and  $\nu'_o$  are laser beams each comprising a continuous series of mode-locked  
pulses.

15       7. The apparatus of claim 6, wherein the monochromatic laser beams at frequencies  $\nu_o$   
and  $\nu'_o$  are laser beams each comprising a continuous series of femtosecond  
pulses.

20       8. The apparatus of claim 2, further comprising:  
reflective mirrors forming an optical cavity about the gas volume containing vessel;  
and  
means for directing said beams to propagate collinearly in said laser optical cavity for the  
time required for self-sustaining generation of light at frequencies  $\nu_o$  and  $\nu'_o$  to  
occur.

9. The apparatus of claim 1, further comprising:

reflective mirrors about said gas volume containing vessel allowing multi-pass

amplification of light at frequencies  $\nu_o$  and  $\nu'_o$  to occur.

**10.** The apparatus of claim **1**, wherein continuous and efficient conversion of photons of

5 fluorescence into photons of coherent light beams at frequencies  $\nu_o$  and  $\nu'_o$  occurs by the nonlinear process of stimulated hyper-Raman scattering (SHRS) occurring at every point within said gas volume containing vessel whereat both said emitted fluorescence intensity and said propagating light beam intensities are present.

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**11.** The apparatus of claim **1** wherein said three specified-species levels forming a  $\Lambda$ -

type structure with resonance frequencies at  $\nu_o$  and  $\nu'_o$  are both hyperfine levels of the Cs  $6S_{1/2}$  ground electronic state and one hyperfine level of the Cs  $6P_{1/2}$  excited electronic state.

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**12.** The apparatus of claim **1**, wherein said three specified-species levels forming a  $\Lambda$ -

type structure with resonance frequencies at  $\nu_o$  and  $\nu'_o$  are both hyperfine levels of the  $6P_{1/2}$  ground electronic state of  $^{203}\text{Tl}$  and the  $F' = 1$  hyperfine level of the  $7S_{1/2}$  excited electronic state of said same thallium isotope.

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**13.** The apparatus of claim **1** wherein said three specified-species levels forming a  $\Lambda$ -

type structure with resonance frequencies  $\nu_o$  and  $\nu'_o$  are both hyperfine levels of the  $6S_{1/2}$  ground electronic state of either singly ionized  $^{199}\text{Hg}$  or  $^{201}\text{Hg}$  and a hyperfine level of the  $6P_{1/2}$  excited electronic state of the same singly ionized isotope that is coupled by dipole-allowed transitions to both said lower levels.

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**14.** The apparatus of claim **1**, wherein said three specified-species levels forming a  $\Lambda$ -

type structure with resonance frequencies at  $\nu_o$  and  $\nu'_o$  are two hyperfine levels of the  $5P_{3/2}$  ground electronic state of any singly ionized odd isotope of Xe and one hyperfine level of the  $5S_{1/2}$  excited electronic state of the same singly ionized isotope that is coupled by dipole-allowed transitions to both lower levels.

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**15.** The apparatus of claim **1**, further comprising a plurality of gas volume containing

vessels wherein each vessel is a source emitting two output beams of highly monochromatic coherent radiation at frequencies  $\nu_o$  and  $\nu'_o$ .

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**16.** The apparatus of claim **15**, wherein the output beams of each of the plurality of gas-

volume containing vessels are arranged as an array and directed to point in the same direction, and wherein the phase of each beam is varied to form a *phased directional array*.

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**17.** The apparatus of claim **16**, further comprising a cascaded series of increasingly sized

gas volume containing vessels for each beam, wherein the output of each of the plurality of sources is directed into a cascade of increasingly sized gas volume containing vessels.

5    **18.** The apparatus of claim **1**, further comprising a cascaded series of increasingly sized gas volume containing vessels, wherein the amplified light at frequencies  $\nu_o$  and  $\nu'_o$  is amplified in the cascade of increasingly sized gas volume containing vessels.

10    **19.** The apparatus of claim **1**, wherein said gas volume containing vessel is a heat-pipe discharge tube (HPDT).

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